JUNCUS DIGITATUS (JUNCACEAE), A NEW ANNUAL RUSH FROM SHASTA COUNTY, CALIFORNIA, U.S.A.

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ABSTRACT

Juncus digitatus is an annual described from two localities in the foothills of the Cascade Range in Shasta County, California. It is separable from *Juncus triformis* by its later flowering period, linear fruits with an acuminate apex, longer capsules 11–17 mm; and fruits that are 3–4 times as long as the tepals. A key to *Juncus* section *Caespitosi* is provided for western North America.

RESUMEN

Juncus digitatus es una planta anual descrita de dos localidades del piedemonte de la cordillera de las Cascadas, en el Condado de Shasta, California. Es separable de *Juncus triformis* por su período de floración tardío, frutos lineares con un ápice acuminado, cápsulas más largas 11–17 mm; y tépalos 25–30% la longitud de los frutos. Se presenta una clave para *Juncus* sección *Caespitosi* para la región occidental de América del Norte.

KEY WORDS: *Juncus digitatus*, *Juncus* section *Caespitosi*, California, Shasta County, vernal pools

Juncus section *Caespitosi* Cout. is defined as a group of 16 delicate annuals primarily from South Africa and western North America (Kirschner et al. 2002a), alternatively included as annuals within subg. *Graminifolii* (Engelm.) Buchenau (e.g., Brooks & Clemants 2000). Eleven members of section *Caespitosi* are indigenous to California, including four endemics: *Juncus triformis* Engelm., *J. leiospermus* F.J. Herm. var. *leiospermus*, *J. leiospermus* var. *ahartii* Ertter, and *J. luciensis* Ertter (Ertter 1986; Swab 1993). An additional endemic is described here, first collected in 1991 by Dean W. Taylor.

Juncus digitatus C. Witham & Zika, sp. nov. (**Figs. 1–3**). TYPE: U.S.A. CALIFORNIA. Shasta Co.: vernal pool about 10 air km NNE of Shingletown, 2 Jun 1993, *Carol W. Witham 481* (HOLOTYPE: JEPS; ISOTYPES: CAS, MO, OSC, RSA, WTU).

A *Junco triformi* capsulis linearibus acuminatis 11–17 mm longis differt.

Plants annual, 4–10.5 cm tall. **Leaves** essentially basal, sheaths 2–15 mm long, with broad scarious fragile margins tapering to the blade without auricles; blades filiform, 5–20 mm long, with acicular apex 0.2–0.5 mm long. **Stems** (culms) unbranched, 3–7 cm tall, 0.2–0.3 mm thick. **Bracts** often clustered like an involucre, 2–8, ovate or narrowly ovate, acute, scarious or dark purple towards base, 1–1.8 mm long. **Pedicels** 0.5–1.5 mm long. **Flowers** terminal, in clusters of (1–)2–8, trimerous. Tepals uniformly 6, narrowly lanceolate, 3.5–4.4 mm long, 0.6–0.7 mm wide, the inner (petals) usually 0.4–0.7 mm longer than the outer (sepals); midvein green with red border, 0.1–0.3 mm wide, often with scattered low papillae at 40×, the tips dark purple; with narrow pale margins 0.1–0.2 mm wide to the apex; tepal margins scarious; apex acuminate to attenuate, erect to slightly recurved at tip. **Stamens** 3, 2–2.5 mm long; filaments 0.6–0.8 mm long; anthers often somewhat sagittate-based, 1.1–2.1 mm long, ca. 2 times the length of the filaments. Style 1–1.5 mm long, elongating to 2.7 mm in fruit; stigmas (2)3, 1.6–5 mm long, reddish, exserted 1.5–3 mm beyond the tepals at anthesis. **Capsules** linear, often slightly curved, (2)3-valved, c. 3–4 times as long as the tepals, (7–)11.3–17 mm long, (0.4–)0.7–1 mm wide, brown to red or dark red to dark brown, similar in color to the tepals, the apex acuminate and gradually tapered into base of the persisting style. **Seeds** 9–20 per row and ca. 10–50 per capsule, ellipsoid to ovoid or narrowly ovoid, 0.5–0.65 mm long, 0.35–0.4 mm wide, shiny, dark brown, at 10× with 10–12 strong longitudinal striations and faint cross-striations, base blunt or with dark broad stipe 0.05 mm long, apex pale, short apiculate. Chromosome number unknown.

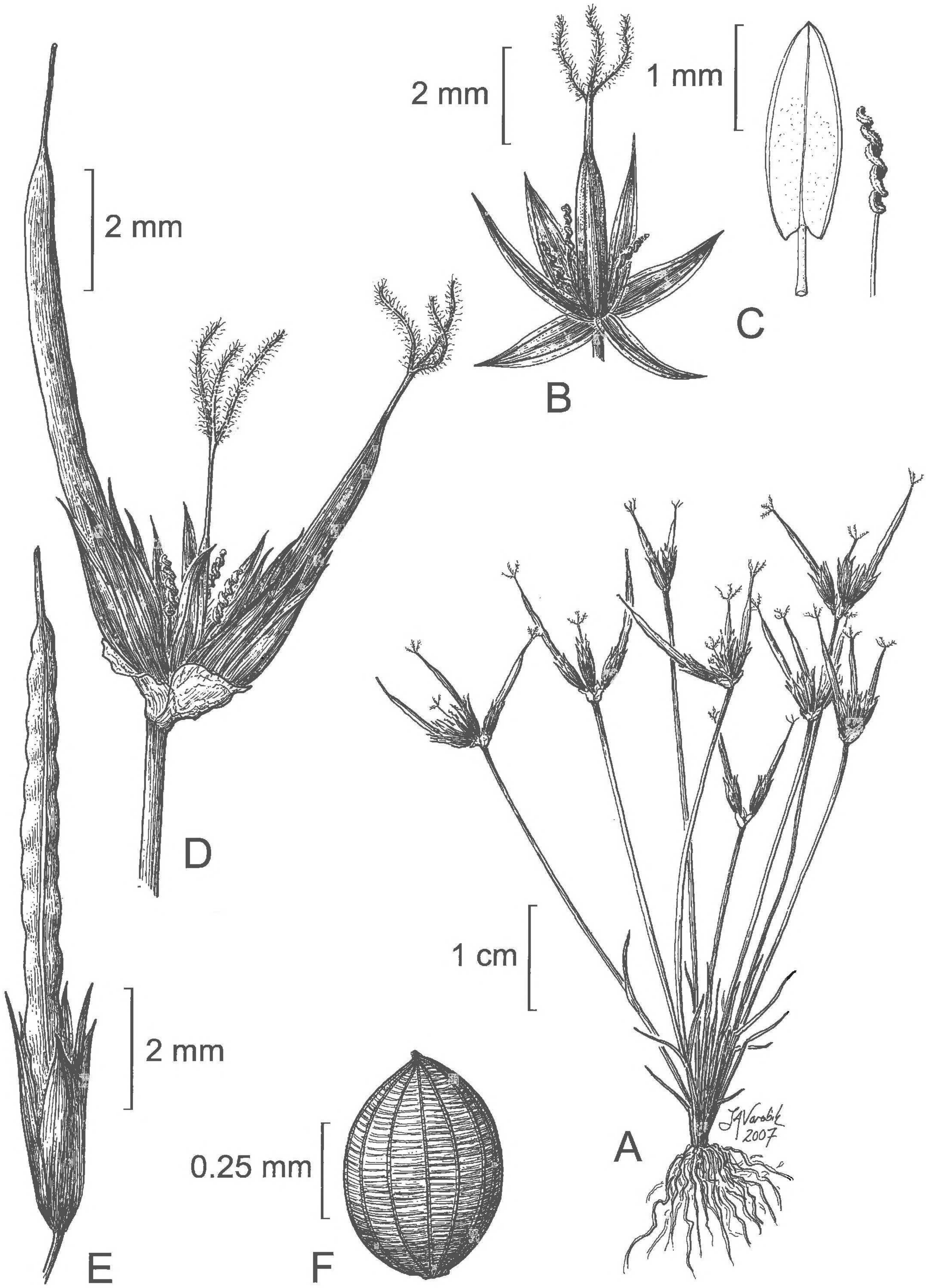

FIG. 1. *Juncus digitatus*. **A.** Habit. **B.** Flower, with exserted stigmas, erect anthers and spreading tepals. **C.** Anthers, fresh and old. **D.** Inflorescence with flowers and immature capsules. **E.** Mature capsule. **F.** Seed, with prominent longitudinal striations. (A-E drawn from *Witham 1259*; F from *Zika 23021 & Witham*.)

Etymology.—We have selected *digitatus,* a name that suggests the finger-like aspect of the unusual fruit clusters.

PARATYPES: **U.S.A. CALIFORNIA. Shasta Co.:** Shingle Creek along Highway 44, 29 May 1991; *D.W. Taylor 11835* (JEPS, mixed sheet with *J. triformis*); same site, 20 May 1992, *C.W. Witham 443* (JEPS); same site, 27 May 1992; *D.W. Taylor 12657 & C.W. Witham* (JEPS); same site, 2 Jun 1993; *C.W. Witham 480* (CHSC, DAV, GH, JEPS, NY); same site, 3 Jun 1993, *D.W. Taylor 13561* (UC); same site, 18 May 2007, *C.W. Witham 1258* (DAV); same site, 4 Jun 2007, *P. F. Zika 23015 & C.W. Witham* (CAN, DAV, UC, US, WTU); Hamp Creek, 25 May 1993, *D.W. Taylor 13498* (JEPS, UC); same site, 18 May 2007, *C.W. Witham 1259* (DAV); same site, 4 Jun 2007, *P. F. Zika 23021 & C.W. Witham* (DAV, GH, MO, NY, PRA, RSA, UC, WTU).

DISTRIBUTION AND ECOLOGY

Juncus digitatus is known only from two populations in Shasta County, from the foothills of the Cascade Range at the northern end of the Sacramento Valley. Populations are in full sun, in the vernally damp ground of seeps, vernal pools, and swales on gentle slopes over volcanic bedrock, at elevations of 660–790 m. Its common associates include *Allium amplectens* Torr., *Centaurium venustum* (A. Gray) B.L. Rob., *Cyperus squarrosus* L., *Deschampsia danthonioides* (Trin.) Munro, *Epilobium pallidum* (Eastw.) Hoch & P.H. Raven, *Eryngium articulatum* Hook., *Isoetes nuttallii* A.Braun ex Englem., *Juncus bufonius* L., *J. acuminatus* Michx., *Mimulus guttatus* Fisch. ex DC., *Muhlenbergia richardsonis* (Trin.) Rydb., *Navarretia intertexta* (Benth.) Hook., *Odontostomum hartwegii* Torr., *Polygonum bolanderi* Brewer, and *Trichostema laxum* A. Gray. Surrounding forest is dominated by *Pinus ponderosa* Douglas ex Lawson & C.Lawson, *P. sabiniana* Dougl. ex D.Don, and *Quercus douglasii* Hook. & Arn.

One population of *Juncus digitatus* grows within a few meters of plants of *J. triformis*, although the two species vary in their flowering period and microsite preference. In the same vernal pool complex *J. triformis* prefers slightly drier positions and is in fruit when *J. digitatus* is in flower in mid-May. *Juncus digitatus* fruits in late May and early June.

RELATIONSHIPS

Juncus digitatus is most closely related to *J. triformis*, and the two have similar outcrossing pollination biology, with anthers much larger than the filaments, spreading tepals, and exserted stigmas when in bloom. Their habit, habitat, tepals, foliage and seeds are also similar; both species are in *Juncus* section *Caespitosi* and endemic to California. *Juncus triformis* capsules are 1–3 mm long, including the beak. *Juncus digitatus* is unique in the genus with its *Lotus*-like clusters of linear capsules 11–17 mm long. No other *Juncus* regularly have capsules more than 10–11 mm long, among the 315 species covered in the comprehensive catalogues of Kirschner (2002a, 2002b), Balslev (1996), or Brooks and Clemants (2000). *Juncus triformis* tepals generally exceed (rarely equal) the length of the capsule; in *J. digitatus* the mature capsule is about 3–4 times as long as the tepals. *Juncus digitatus* capsules are linear, often curved, and gradually tapered to the persistent style on the apex; in *J. triformis* the capsule is generally ovoid to ellipsoid, and the apex is usually abruptly tapered to the persisting style base.

Our field work found that *J. triformis* is absent at one of the two populations of *J. digitatus*. This is significant, demonstrating that the two species retain their morphological differences in the same habitat, or when growing isolated from each other (Wagner & Wagner 1983). Intermediates are not known. This mingling in some sites without intermediates, and growing isolated elsewhere, parallels the situation among a number of other western North American species of *Juncus* section *Caespitosi* reported in Ertter (1986) and supports our argument that *J. digitatus* should be treated at the rank of species.

Ertter (1986) points out that *Juncus triformis* is unusually variable in several morphological features, including "coloration, shape, and relative proportions of inner tepals, outer tepals, capsules, and seeds." Hermann (1948) was unaware of this extensive and continuous morphological gradation, and split from *Juncus triformis* high elevation plants with relatively slender culms and large seeds, which he called *J. megaspermus* F.J. Herm. After reviewing the variation in specimens of *J. triformis* from across California, using the collections at CAS, CHCS, DS, GH, JEPS, OSC, POM, RSA, UC, UCR, and WTU, we agree with Ertter

Fig. 2. Photo of *Juncus digitatus* habit.

(1986) and Kirschner (2002a) that the type of *J. megaspermus* is not a significant variant and belongs in the synonymy of *J. triformis*. Nor have we found any other name in the synonymy of *J. triformis* that would apply to and have priority over *J. digitatus*.

A key to annual *Juncus* with simple stems and terminal flowers in North America is provided to aid in identification of the species. Mature capsules and ripe seeds are essential.

KEY TO *JUNCUS* SECTION *CAESPITOSI* IN NORTH AMERICA

1. Lower inflorescence bracts prominent, erect, appearing to be a continuation of the stem, much longer than the inflorescence; outer tepals long-acuminate, much longer than acute to blunt inner tepals; Eurasian introduction _____ **J. capitatus** Weigel
1. Lower inflorescence bracts inconspicuous, not erect, much shorter than the inflorescence; outer tepals similar in shape and length to inner tepals, sometimes inner tepals longer than outer tepals; native to western North America.
   2. Anthers 0.9–3.2 mm long, longer than filaments, styles 0.9–4 mm long (flowers outcrossing).

FIG. 3. Photo of *Juncus digitatus* flower and immature capsules.

3. Capsules 11–17 mm long, about 3–4 times as long as tepals ____ **J. digitatus** C. Witham & Zika
3. Capsules 1–5 mm long, shorter than or about as long as tepals.
   4. Tepals acuminate; seed longitudinally striated (at 15×); inner tepals colored to apex; inner tepal margins narrowly scarious ____ **J. triformis** Engelm.
   4. Tepals acute; seed not longitudinally striated; inner tepals not colored to apex, both inner and outer tepal margins broadly scarious ____ **J. leiospermus** F.J. Herm.
      5. Flowers usually solitary (rarely 2) per stem ____ **J. leiospermus** var. **ahartii** Ertter
      5. Flowers usually 2–4 (rarely 7) per stem ____ **J. leiospermus** var. **leiospermus**

2. Anthers 0.15–0.5 (0.8) mm long, shorter than filaments, styles 0–0.5 mm long (flowers self-pollinating).
   6. Seeds longitudinally striated (at 15×); flowers 1–2 (rarely 7) per stem; bracts 2, acute to acuminate.
      7. Tepals usually 4.
         8. Mature capsule usually subglobose, shorter and sometimes paler than tepal tips; seeds 0.5–0.8 mm long; 2–3 seeds per locule, 4–9 seeds per capsule ____ **J. capillaris** F.J. Herm.
         8. Mature capsule elliptic to oblong, usually equaling or longer than similarly colored tepals; seeds 0.4–0.5 mm long; 4–7 seeds per locule, 10–30 seeds per capsule ____ **J. tiehmii** Ertter
      7. Tepals usually 6.
         9. Tepals usually longer and darker than the capsule; 4–9 seeds per capsule; longitudinal ridges on seeds often faint even at 30×; seeds 0.5–0.8 mm long ____ **J. capillaris** F.J. Herm.
         9. Tepals usually shorter and the same color as the capsule; 40–50 seeds per capsule; longitudinal ridges on seeds weil-developed at 30×; seeds 0.3–0.6 mm long.
            10. Stems usually with 2–3 (rarely 1 or 4) flowers; capsule and tepals ultimately dark reddish; seeds 0.4–0.6 mm long ____ **J. kelloggii** Engelm.
            10. Stems usually with solitary (rarely 2) flowers; capsule and tepals ultimately pale yellowish-green (tepal midveins dark red distally); seeds 0.3–0.4 mm long ____ **J. luciensis** Ertter
   6. Seeds not longitudinally striated; flowers solitary; inflorescence bracts absent or 1–2, truncate to acute.
      11. Inflorescence bracts absent; stem thickened below flower ____ **J. hemiendytus** F.J. Herm. var. **abjectus** (F.J. Herm.) Ertter
      11. Inflorescence bracts 1–2; stem filiform, not thickened below flower.
         12. Inflorescence bracts solitary, apex truncate, sheathing stem; stamens 2–3 ____ **J. uncialis** Greene
         12. Inflorescence bracts 1–2, apex acute to blunt, not sheathing stem; stamens 2–4.
            13. Tepals usually 6, shiny, incurved and longer than capsule; inflorescence bracts 2 ____ **J. bryoides** F.J. Herm.
            13. Tepals usually 4, dull, erect or slightly outcurved and usually shorter than capsule; inflorescence bracts 1–2 ____ **J. hemiendytus** var. **hemiendytus**

CONSERVATION CONCERNS

Juncus digitatus joins a list of narrow endemics restricted to Shasta County, including *Ageratina shastensis* (D.W. Taylor & Stebbins) R.M. King & H. Robins., *Ivesia longibracteata* Ertter, *Neviusia cliftonii* Shevock, Ertter & D.W. Taylor, and *Puccinellia howellii* J.I. Davis. Like *Juncus digitatus*, several Shasta County endemics are rare and have conservation issues. Due to the small populations and the restricted geographic extent of *Juncus digitatus*, we have not provided exact locality data. The lead author has invested many field seasons searching for this species, without adding more localities. Certainly more study and inventory is needed. Nonetheless *J. digitatus* seems an appropriate candidate for attention from the conservation community, as a narrow endemic on private lands in one county, in a wetland habitat that has been largely converted into agriculture or rangeland. About half the available habitat at the Hamp Creek population has been lost in recent years to a piped diversion of spring water.

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